Food and Agriculture Organization of the United Nations

CASE STUDY

INTEGRATION of SEPAL into UGANDA's NATIONAL FOREST MONITORING SYSTEM

This case study summarizes the experience of the use of System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL) in Uganda by the National Forest Authority (NFA) and its integration into the National Forest Monitoring System (NFMS), as a result of a long-standing partnership that began in 2013 between Uganda's Geographic Information System (GIS) and Remote Sensing team and the National Forest Monitoring team from the Food and Agriculture Organization of the United Nations (FAO).

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What is SEPAL?

SEPAL is a free, open-source, online platform that enables autonomous processing of geospatial data for customized land and forest monitoring by anyone, anywhere. Part of the Open Foris suite of tools, the platform empowers users to process satellite data, create maps, and detect land cover and land-use change, and many other functions critical for generating data for effective land management without the need of coding skills.

The context

Before the introduction of cloud-computing platforms such as SEPAL, mapping and monitoring land cover and forest changes in Uganda was done manually using various independent tools, which made the process time-consuming, error-prone, inefficient, and tedious. This, added to the limited processing and storage capacities of local computers, hindered the efficient and effective processing and analysis of satellite data.

In addition, forest and forest change information was limited since it depended on the availability of at least two land cover maps to observe where and how much forest gain or loss occurred in a given period of time, making the information inadequate for informing policymakers and implementers about what was happening on the ground.

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MAIN ACTORS AND STAKEHOLDERS

The GIS and Remote Sensing team of the NFA was the main actor in the process of integrating SEPAL into Uganda's Forest Monitoring System. The NFA and FAO teams worked together to integrate and improve the NFMS with SEPAL tools, making the NFA team an active contributor to the developmental phase of SEPAL.

FAO technical assistance in the use of SEPAL and its tools were funded by the Government of Japan, Norway's International Climate and Forest Initiative (NICFI), the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD Programme), and the World Bank.

TARGET BENEFICIARIES

At the country level, there have been more frequent and accurate forest statistics produced with state-of-the-art tools available in SEPAL.

At a technical level, the NFA team benefited from the capacity development activities provided by FAO: 13 experts from the NFA team, including 6 females, were better equipped with the necessary skills to carry out their day-to-day monitoring of forest and land cover monitoring activities.

OBJECTIVES

The main objective was to introduce the cloud-computing SEPAL platform to the work of the NFA team for a more efficient, consistent, and transparent production of land cover and forest change information, in particular:

- to process, store and analyse satellite images efficiently and effectively;
- to produce accurate, transparent, and consistent forest change statistics; and
- to improve the usability and applicability of the tools in SEPAL for Uganda and elsewhere globally, through co-development with the SEPAL team.

METHODOLOGICAL APPROACH

The integration of SEPAL into the NFMS of Uganda was done in numerous ways, as described below.

Accessing and processing of satellite images

SEPAL provides a user-friendly interface access to a variety of free satellite image sources from the European Space Agency (ESA), the National Aeronautics and Space Administration (NASA), and NICFI Planet data. The images available through the platform are analysis ready, so preprocessing steps such as atmospheric correction and cloud masking are automatically applied to the images, providing the NFA team with one easy to use tool. Therefore, the NFA team does not need to perform those tasks using other tools.

Land Cover Land Use (LULC) classification

Uganda used to implement a complex approach that involves satellite image segmentation and classification to produce land cover and land use maps. Performing these tasks using a normal computer was problematic and inefficient as they required a large amount of power for data processing and storage. When these tools were incorporated into the SEPAL platform, Uganda quickly adapted them.

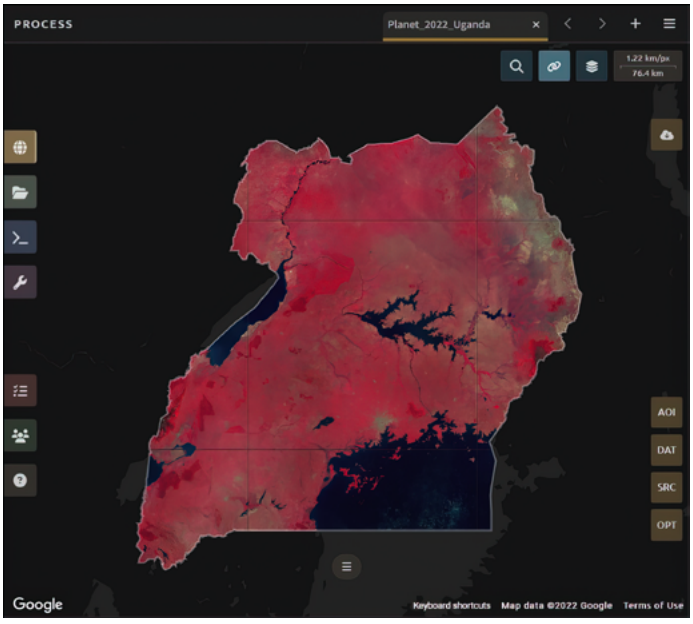
Forest change detection

Various change detection methods for efficient monitoring of forest changes are available in SEPAL. Techniques such as the BFAST (Breaks for Additive Season and Trend) algorithm have been thoroughly tested and implemented by the country to detect changes in forest cover at both national and sub-national levels. Instead of comparing land cover maps, the techniques use a time series of satellite images to detect changes over time and space. This allows the country to report timely and accurate forest change information in order to inform policy, compared to the five-year reporting period before the adaption of SEPAL.

SEPAL also has tools to assess the accuracy and estimate areas of forest change for reporting for Reducing Emissions from Deforestation and Forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+). These tools were developed following the good practice guidance for measuring and reporting forest area and forest area change from the Intergovernmental Panel on Climate Change (IPCC).

FIGURE 1

False colour NICFI Planet mosaic created using SEPAL, 2022



Source: FAO. 2022. SEPAL: Uganda. In: *SEPAL*. Rome. Cited 14 December 2022. https://sepal.io

RESULTS

Efficient creation and processing of satellite mosaics

One of the best achievements was the ability to create a national-level satellite mosaic within minutes or hours (Figure 1). Before SEPAL, the process would take the country over a month to obtain all the necessary images for processing and analysis. In addition, it was not possible to create a mosaic for the entire country.

Land Cover Land Use map created in SEPAL

With SEPAL, it is now possible to create a national LULC map based on a Landsat-8 mosaic (30 m spatial resolution) or Planet NICFI data (5 m spatial resolution) within one hour, which would take over a month without SEPAL. As compared to a previous five-year cycle, Uganda now produces and reports land cover maps on a yearly basis after a manual validation process of editing and ground truthing to improve the land cover map.

Forest change data and information

Uganda has been producing forest area and forest change information using the SEPAL platform. The information has been reported on the national and international levels such as in the Forest Reference Emission Level (FREL) and the Biennial Update Report with REDD+ results submitted to the United Nations Framework Convention on Climate Change (UNFCCC).

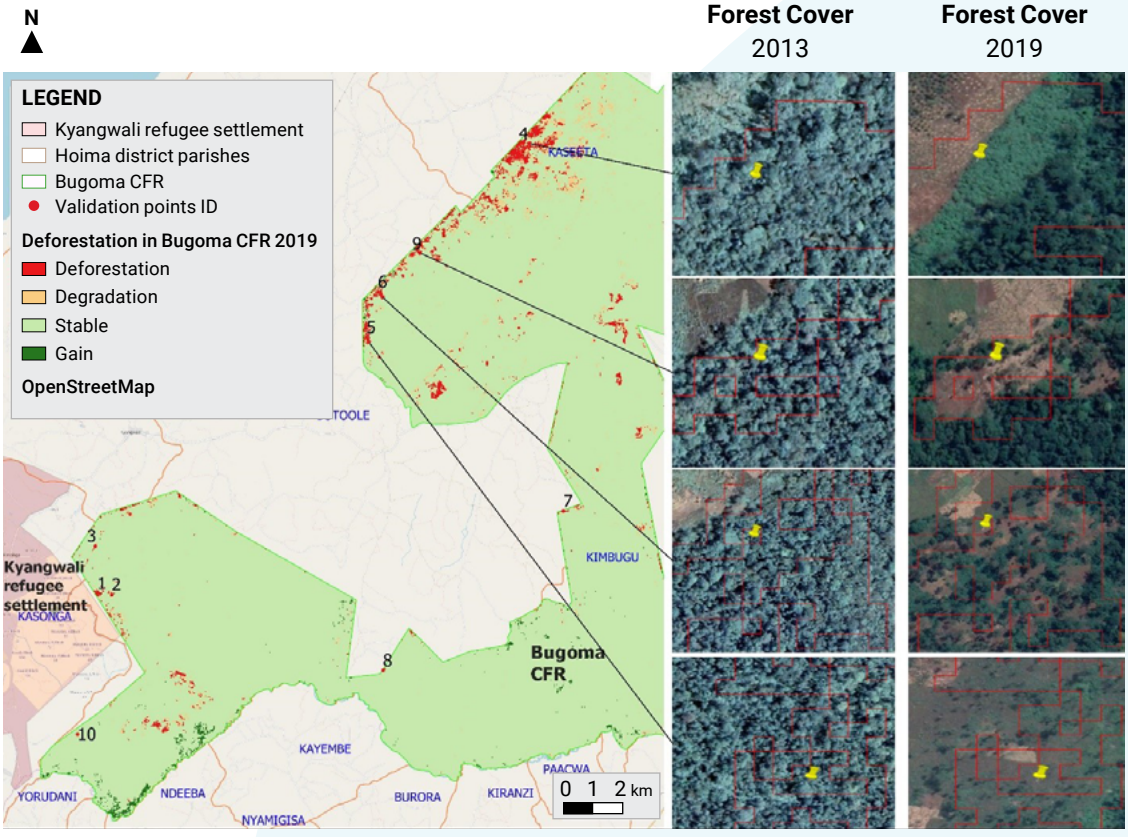
Site-specific change assessments to monitor deforestation, forest degradation, and restoration are carried out in various parts of the country using novel data sources such as the NICFI Planet high resolution satellite imagery. As a result, due to numerous reports from NFA field staff about the deforestation and degradation happening in Bugoma Central Forest Reserve (Bugoma CFR), an assessment was carried out to confirm the information and estimate the location and extent of tree cover loss (Figure 2).

To enhance the protection of Uganda's forest reserves, physical concrete pillars are established along the reserve boundary. Time series analyses in SEPAL are carried out to assess the past and current situation of the forest boundary. Before field surveys, the team gets a remote idea of what the actual location and extent of the reserve were before encroachment, thus saving time, money, and energy.

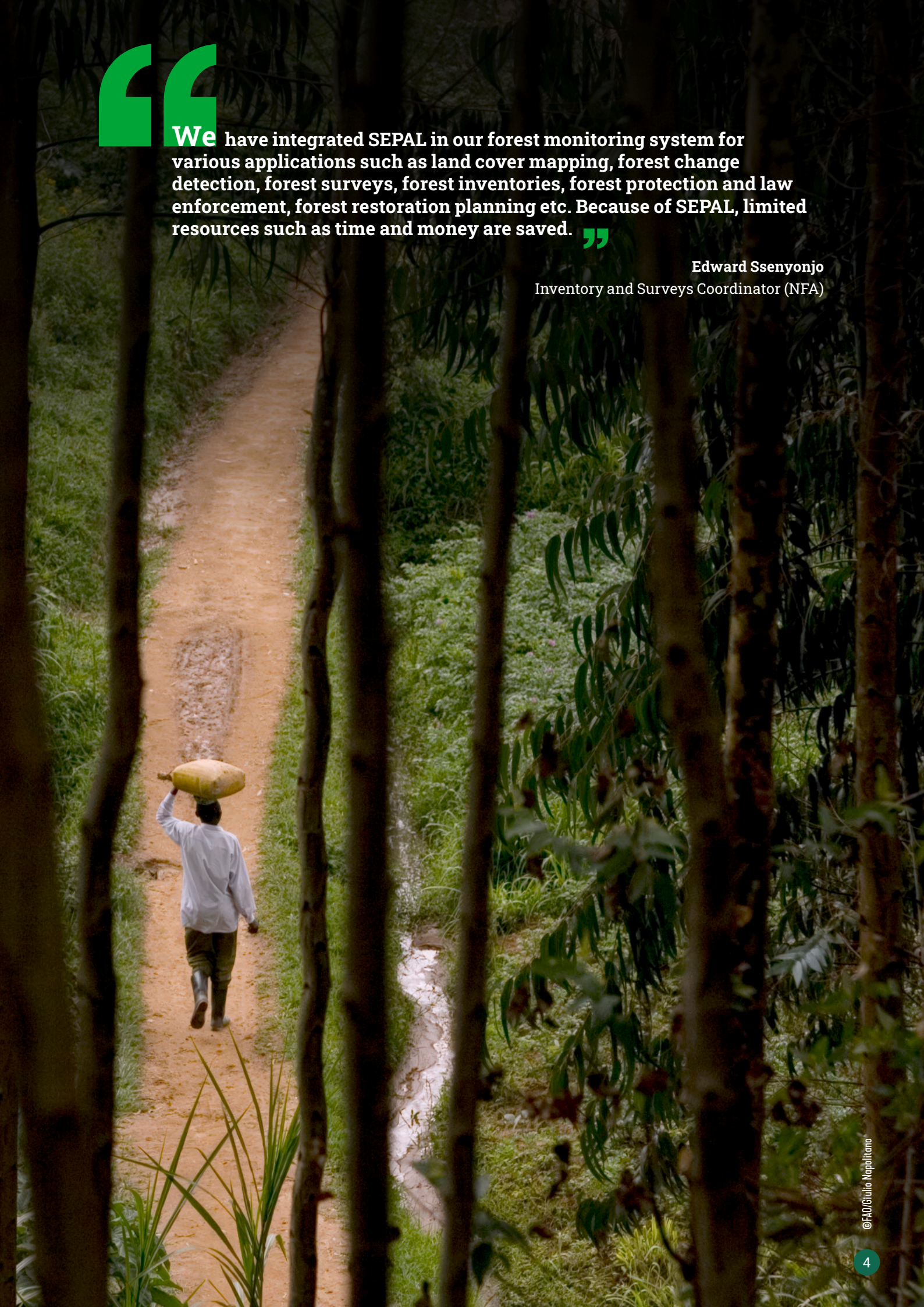
This approach also helps in resolving conflict with encroachers by showing proof of the extent of the forest before it was destroyed. In addition, it helps in financial resource planning by estimating how much money is needed to carry out boundary surveys and opening work for a particular reserve.

FIGURE 2

Deforestation and degradation in Bugoma CFR, 2019



Source: FAO. 2020. Mapping forest degradation using remote sensing data in Uganda. In: *FAO*. Rome. Cited 20 May 2020. https://www.fao.org/redd/news/detail/en/c/1267106/



We have integrated SEPAL in our forest monitoring system for various applications such as land cover mapping, forest change detection, forest surveys, forest inventories, forest protection and law enforcement, forest restoration planning etc. Because of SEPAL, limited resources such as time and money are saved.

Edward Ssenyonjo
Inventory and Surveys Coordinator (NFA)

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IMPACT

At a national level, frequent, near real-time monitoring of forest changes is helping to inform policy makers to make immediate, informed decisions on the ground. With the use of SEPAL, encroachments on protected areas such as deforestation and degradation are detected and reported for faster mitigation and prevention of further destruction. Forest restoration activities are also easily monitored to show whether the interventions are being implemented as planned. Additionally, it is helping to enhance forest protection and conservation by saving resources such as time and money to implement and enforce policies. Furthermore, the area and volume estimation of a forest plantation for timber harvesting has also been made easier, faster and cheaper by using SEPAL tools.

At the international level, Uganda has become the first African country to submit REDD+ results to the UNFCCC, paving the way to potential results-based payments. Uganda continues to demonstrate REDD+ results by using various tools in the SEPAL platform.

SUCCESS FACTORS

With the financial and technical support provided by FAO and other partners, the integration of SEPAL into the NFMS of Uganda was a smooth and successful process.

CONSTRAINTS

Limitations were related to staff going into retirement or leaving the NFA geospatial team and not being replaced, resulting in fewer technicians for SEPAL training and use. Together with NFA counterparts, FAO drafted terms of references for the NFA geospatial team, highlighting the need for additional support, which they used to procure an additional team member. There were also project funds found to finance additional members, with an understanding that these technicians would eventually become NFA employees.

SUSTAINABILITY

Investing in human resources is the key to sustainability. Once it is understood that these tools and platforms make data generation much easier for national reporting, as evidenced by SEPAL, the greater the impetus to grow capacity in its use.

REFERENCES

FAO. 2020. Uganda becomes the first African country to submit REDD+ results to the UNFCCC. In: *FAO*. Rome. Cited 24 June 2020. www.fao.org/redd/news/detail/fr/c/1295567

National Forest Authority. 2009. *National Biomass Study*. Kampala. www.nfa.go.ug/images/reports/biomasstechnicalreport2009.pdf

ACKNOWLEDGMENTS

This case study was developed by the SEPAL team, with contributions from the Uganda NFA GIS and Mapping team.

Testimonials

"SEPAL is one of the best and useful tools we have had in the GIS and remote sensing world. Our GIS and remote sensing experts use SEPAL on a daily basis. No one spends a day without accessing and using SEPAL. We don't think there is anybody in Uganda that uses SEPAL more than our staff at NFA."

John Diisi
GIS and Mapping Coordinator (NFA)

"Before SEPAL, we used to depend on various sites such as USGS Earth Explorer and Glovis to access different satellite images, but with SEPAL you can find everything there. With SEPAL, there is no need to run from one site to the other to access images. In addition to accessing images, we can create cloud-free mosaics, perform heavy processes, run spatial analyses, store data and others."

Edward Ssenyonjo
Inventory and Surveys Coordinator (NFA)

RELATED RESOURCES

Uganda's NFA website
www.nfa.go.ug

SEPAL website
www.fao.org/in-action/sepal

SEPAL platform
https://sepal.io

SEPAL documentation
https://docs.sepal.io/en/latest

IPCC good practice guidance
https://redd.unfccc.int/uploads/2_77_redd_20140218_mgd_report_gfoi.pdf

Uganda's REDD+ submissions
https://redd.unfccc.int/submissions.html?country=uga

NICFI
Norway's International Climate and Forest Initiative

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